

REMARKS

Claims 1, 6, 7, 10, 13-16 and 18-19, 23-25, 28-29 and 32-34 are pending.

Claim 11 has been cancelled without prejudice or disclaimer.

I. Claim Amendments

Claim 1 was amended to recite the subject matter of (now cancelled) claim 11.

Claim 1 was also amended to remove reference to series AA5xxx and AA6xxx alloys to be consistent with the incorporation of the composition of claim 11 into base claim 1.

Claim 10 has been amended to remove recitation of series AA6xxx alloys to be consistent with the amendment to base claim 1.

The Amendment neither adds new matter nor raises new issues.

II. 35 USC §103(a)

A. Claims 1, 6, 7, 10, 13, 14, 19, 23–25, 28, 29, 32, 33 and 34

Claims 1, 6, 7, 10, 13, 14, 19, 23–25, 28, 29, 32, 33 and 34 stand rejected under 35 USC §103(a) as being unpatentable over AAPA (which the Examiner considers "Applicant's Admitted Prior Art" disclosed by Applicant's specification at pages 1-3) in view of Warner et al. (US Patent 6,569,542).

Amended claim 1 includes the subject matter of previous claim 11. Claim 11 was not rejected as being unpatentable over AAPA in view of Warner et al. Moreover, each of the pending claims depends from claim 1. Thus, this rejection is overcome.

B. Claims 11 and 18

Claims 11 (now Claim 1) and 18 stand rejected under 35 USC §103(a) as allegedly being unpatentable over AAPA in view of Warner et al., as applied to Claim 1, further in view of Quist et al. (U.S. Patent No. 4,305,763).

The Office Action asserts the alleged AAPA discloses a method for producing an integrated monolithic aluminum structure for a part of a wing skin or frame structure for an aircraft wherein an aluminum plate with a thickness in the range of 15 to 75 mm is bent to form a predetermined shaped form and, after the bending operation, the plate is machined to produce the

monolithic structure. It appears the Office action is pointing to Paragraphs [004] - [009], more specifically the method described at Paragraph [008], of the originally filed specification.

The AAPA does not disclose heat treating the shaped structure comprising artificially ageing the shaped structure to a T6, T79, T78, T77, T76, T74, T73 or T8 temper prior to machining.

1. It is Improper to Combine AAPA with Warner et al.

AAPA discusses various AA7xxx series alloys. Warner et al. only teaches its method for AA2001-type alloy. Warner, Col. 2, line 66 - Col. 3, line 7, states:

"The purpose of the invention is a structure element, particularly a lower wing element, manufactured from a rolled, extruded or forged product made of an alloy with composition (% by weight): Cu=4.6-5.3, Mg=0.10-0.50, Mn=0.15-0.45, Si<0.10, Fe<0.15, Zn<0.20, Cr<0.10, other elements <0.05 each and<0.15 total, the remainder being Al treated by solution heat treating, quenching, controlled tension to more than 1.5% permanent deformation and aging."

Likewise, Warner, col. 3, lines 39-43 states, "The invention is based on the observation that a 2001 type alloy with some changes to composition and an appropriate manufacturing procedure, can have a set of properties making it suitable for use in aircraft structures ...."

As a result, Applicants respectfully present no *prima facie* case of obviousness has been made.

2. Warner et al. Does Not Solve the Problem of AAPA

AAPA does not heat treat (artificially age to the desired temper) the bent and machined structure described in paragraph [008]. The plate from which the structure was made was heat treated to the desired temper before bending and machining. This is illustrated by the Example at paragraph [0048], where the plate has been aged to a T351 temper prior to bending and is not (further) aged after being bent.

As stated in the application at paragraph [009], the bending and the machining results in considerable distortion. Paragraph [009] of the AAPA also explains this bent and machined structure comprising sheet and stringers or beams displays residual or inner stress originating

from such bending, which results in regions with less and more internal stress. The regions with more internal stress tend to be considerably more susceptible to corrosion and fatigue crack propagation. As further explained in paragraph [0043] on page 9, “A disadvantage of this approach is that there may be significant residual stress in the product, and this may lead amongst others to increasing the cross-section of frame members or the skin itself to meet required tolerances and safety requirements.”

In contrast to the AAPA, the present invention ages after shaping. The present invention shapes, e.g., bends, a plate to form a curved or shaped structure, then the shaped structure is aged, and then if desired is it machined into an integrated monolithic structure. The present invention’s ageing after shaping is in addition to other ageing that may have occurred before shaping.

The Office action agrees the AAPA does not disclose heat treating the shaped structure comprising artificially ageing the shaped structure to a T6, T79, T78, T77, T76, T74, T73 or T8 temper prior to machining. Thus, to make up for this deficiency the Office action asserts Warner et al. (US 6,569,542). The Office action asserts Warner et al. teaches producing integrated monolithic aluminum structure by:

providing an aluminum alloy plate with predetermined thickness, the plate having been stretched in a range greater than 1.5% after quenching (col. 4, lines 11-32),

bending the alloy plate to obtain a predetermined shaped structure and heat treating the shaped structure to artificially age the shaped structure to a T6 condition (col. 4, lines 37-42), and

machining the shaped structure (col. 3, lines 36-37 and col. 4, lines 59-62).

It is respectfully submitted Warner et al. does not make up for the deficiencies of AAPA.

- a. Warner et al. suggests forming (if any) occurs during artificial ageing whereas in the present invention shaping comprises cold forming prior to ageing

Present Claim 1, step "b" recites shaping the alloy plate to obtain a predetermined shaped structure having a pre-machining thickness in the range of 10 to 220 mm, wherein the shaping comprises cold forming.

As mentioned above, the AAPA discloses the plate from which the structure was made was heat treated to the desired temper before bending and machining. There is no cold forming prior to ageing.

Warner et al. fails to make up for this deficiency. Warner et al., col. 3, lines 23-30, discloses quenching the hot transformed product; solution heat treating the product; controlled tension of the product; aging the product at a temperature greater than 160 °C, possibly together with forming; and then machining. Likewise, col. 4, lines 34-36, discloses "aging can take place at the same time as the curved shape of the lower wing panel is formed."

Warner et al. is disclosing its process is either making:

- (1) a plate aged and afterwards machined to the final part; or
- (2) a plate aged (with forming, namely bending, during the ageing) and afterwards machined to the final part.

Warner et al is not disclosing the present process which cold forms, e.g., bends, the plate before ageing.

This follows from the overall context of Warner et al.

Above scenario "(1)" follows from the Warner et al. examples which merely make plates and do not shape the plate. In Example 1, as stated at col. 5, lines 17-20, "380x120 mm cast plates were homogenized, hot rolled to a thickness of 22 mm, solution heat treated, quenched in cold water, stretched to a 2.3% permanent deformation and aged." Example 2 also merely makes plates. Example 3 also merely makes plates and concludes as follows: "These plates are particularly suitable for the manufacture of aircraft lower wing elements using a manufacturing procedure including machining and one or several shaping operations."

Above scenario "(2)" follows from Warner et al., col. 2, lines 44-55 which discloses the following:

Finally, aircraft wings, particularly for high capacity aircraft, have a curved wing profile with curvature in the longitudinal and in the transverse directions. This complex shape can be obtained in an autoclave during the aging process by forming on a mold, by applying a partial relative vacuum on the surface of the mold side of the plate, lower than the pressure on the other side. It is essential that this operation is successful to avoid expensive scrapping of parts with high added value, and particularly large parts. The key to success is in the lowest possible springback effect for a given mold shape, since springback is frequently the most difficult factor to be controlled.

Thus, the known way to form aircraft wings is to form during ageing. Warner et al. is not teaching away from this known way. Warner et al. has the purpose of supplying aircraft structure elements with properties at least equivalent to specified properties of the same elements made from a 2024 alloy in the T351 temper, as disclosed at col. 2, lines 56-63. Warner et al. is not inventing new steps to form aircraft wings as does the present invention.

Thus, the forming (shaping) of Warner et al., if employed, is the optional forming during ageing discussed above. Neither AAPA nor Warner et al. teaches to cold form (shape) before ageing as recited by the present invention.

- b. The "controlled tension" of Warner et al. is not the "cold forming" of present Claim 1

The "controlled tension" described by Warner et al. at col. 3, lines 28-29 is the stretching described at col. 4, lines 27-29. The purpose of Warner's controlled tension is to obtain a permanent deformation of greater than 1.5% as described at col. 3, lines 27-28. The examples illustrate this as a stretch to a 2.3% permanent deformation as described at col. 5, line 19.

The controlled tension stretching step of Warner et al., and present Claim 1's shaping comprising cold forming step, are not the same steps. This is apparent because Claim 1 step "a" recites "said plate having been stretched after quenching". Consistent with this, paragraph [0022] of the present application discloses stretching up to 8%, but preferably 1-5%. The stretching of present Claim 1, step "a" parallels the controlled tension of Warner et al. In

contrast, Claim 1, step "b" separately recites the additional step of shaping which comprises cold forming. Claim 28 further emphasizes this by reciting the shaping comprises bending.

c. Warner et al. does not bring the plate to a T4, T73, T74 or T76 temper

Another significant difference in the method of Warner et al. and the claimed method is that, after quenching, Warner et al. does not bring the plate to a T4, T73, T74 or T76 temper as recited in claim 1, step "a".

Thus, in the presently claimed process the plate is heat treated twice in two separate operations: (1) in step "a" after quenching but prior to cold forming, and then (2) in step "c" after the shaping operation. In contrast, Warner et al. teaches one heat treatment.

Warner et al. therefore does not disclose the process of the current claimed process and does not make up for the deficiencies of the AAPA even if one skilled in the art combined these references.

3. Quist et al. does not make up for the process deficiencies of AAPA or Warner et al.

Present Claim 1 recites an aluminum alloy selected from the group consisting of AA7xxx-series alloys having Zn 5.0 - 8.5 %, Cu 1.0 - 2.6 % and Mg 1.0 - 2.9 %. The Office action cites Quist et al. for teaching a composition of aluminum alloy within Applicant's claimed range.

Applicants submit that if the 7000 series alloys of Quist et al. were employed in the alleged process disclosed by combining AAPA and Warner et al. the resulting combination still lacks the shaping comprising cold forming of present Claim 1, step "b".

4. Warner et al. requires recrystallization: It is the opposite of Quist et al.: Thus it is Improper to Combine These References

According to Warner et al. it is important that the alloy product is completely recrystallized, see, e.g., col. 4, lines 43-47 and col. 7, lines 32-35. "The resulting metallurgical structure is strongly recrystallized, unlike the structure obtained with 2024 and 2034 alloys, with a recrystallization rate always exceeding 70%, and usually exceeding 90%, over the entire thickness." Warner et al., col. 4, lines 43-47.

In contrast, Quist et al. teaches it is important for the alloy to be hot worked to prevent substantial recrystallization, see, e.g., process step (b) in claim 1, and col. 3, line 50 to col. 4, line 21. This avoidance of recrystallization is required to achieve the desired set of properties. Quist et al., col. 3, lines 50-56, explains this as follows:

in order to maintain the combination of mechanical and fracture properties of the alloy of the present invention, it is important to hot roll, extrude, or otherwise work products of the alloy in a manner that avoids excessive recrystallization of the microstructure of the final product. Avoiding hot working (or cold working) practices which lead to significant amounts of recrystallization is critical, particularly for thinner plate and extrusions, for which there is an increased tendency for recrystallization to occur during solution treatment. Therefore, the product formed from an alloy of the present invention must be substantially unrecrystallized. By "substantially unrecrystallized" it is meant that less than about 50 volume percent of the alloy microstructure in a given product is in a recrystallized form, excepting surface layers which often show a much higher degree of recrystallization. (The surface layers of plate and extrusion products are usually removed during fabrication into final part configurations.) Most preferably, it is desired to maintain the volume percent of recrystallized microstructure less than about 30%.

Thus, it is improper to combine these references. The proposed combination of the teaching of Warner et al. and Quist et al. would render one or the other of the inventions inoperative for its intended purpose because they require opposite microstructures.

5. The problem solved by Warner et al. is irrelevant to the 7xxx-series alloys of Quist et al.

Quist et al. deals with a different problem than that in Warner et al. or AAPA. Quist et al. desires to improve the strength, fatigue properties and fracture toughness of an AA7000-series alloy by carefully controlling the heat treatment and the microstructure of the alloy (col. 2, line 63 - col. 3, line 6).

In contrast, Warner et al. is limited to a method for treating AA2001 type alloys with some process changes to make the AA2001 type alloy composition suitable for use in aircraft structures. As set out at col. 2, lines 19-63, and col. 3, lines 40-47, the purpose of the Warner et al. invention is to supply aircraft structure elements with properties, at least equivalent to specified properties of the same elements made from a 2024 alloy in the T351 temper, based on the observation that a 2001 type alloy with some composition changes and an appropriate manufacturing process can have these properties. Warner et al. is not directed to a method of treating AA7xxx series alloys of the specific composition now recited in amended base independent claim 1.

There is no motivation from Warner et al. to carry over its disclosed process (which differs from the present process) to another alloy category such as that of Quist et al. Moreover, even if one skilled in the art were to attempt this, then that person would have to further modify the process to arrive at the advantages of the present invention.

Thus, the proposed combination involves hindsight.

6. Data shows the present invention method achieves unexpected advantages

The AAPA discloses two methods of prior art processing.

In a first method, the product is bent and stringers or beams are attached as discussed in paragraph [007]. As explained at pages 2-3, paragraph [009], the resulting product from this method has the disadvantage that it displays considerable distortion after the bending and machining operation which makes the assembly of the aircraft fuselage or aircraft wing cumbersome. As explained at page 8, paragraph [0042], “When the additional components 2 are attached to the base sheet 1 and when the whole structure is finished after the machining and riveting or welding step, a horizontal distortion  $d_1$  and/or vertical distortion  $d_2$  usually results from stress relief from the pre-curved plate or sheet which has been bent before additional components 2 are connected to the base sheet or before components 2 are machined from a plate product with a corresponding thickness.” This stress relief is not aging.

Stress relieving is different from aging because stress relieving involves heating a product for a short time period at low temperatures. Aging takes longer and is done in a controlled

manner to achieve desired strength and corrosion resistance. In particular, artificial aging is performed at higher temperatures than the stress relieving mentioned for the first method of the AAPA.

In a second method disclosed in paragraph [007], a plate is heat treated and then bent and then a portion of the heat treated and bent plate is machined away to form stringers and ribs and beams. The second method appears to be the method relied upon by the Office action. As explained by paragraph [009] this bent and machined structure comprising sheet and stringers or beams displays residual or inner stress originating from such bending operation and results in regions with less or more internal stress. Those regions with an elevated level of internal stress tend to be more considerably susceptible to corrosion and fatigue crack propagation. As further explained at page 9, paragraph [0043], “A disadvantage with this approach is that there may be significant residual stress in the product, and this may lead amongst others to increasing the cross-section of frame members or the skin itself to meet required tolerances and safety requirements.” As shown in the below-discussed example, the bent plate prior to machining suffers from distortion and residual stress. It is respectfully submitted that, after machining the bent plate to the desired shape, the residual stress remains.

Thus, the product of the first method suffers from distortion. Moreover, the product of the second method initially suffers from distortion and residual stress and, even after machining, suffers from residual stress. In contrast, the presently claimed product simultaneously avoids distortion and residual stress.

The significant reduction in distortion after machining while using the method according to the present claims is illustrated by the Example of the present specification. In particular, data at pages 9 and 10 of the present application shows the unexpected advantages of the present invention by comparing the following:

a product of the present invention, namely a plate in a T451 temper bent to a structure with a 1000 mm radius followed by artificial ageing to a T351 temper; with

a comparative product, namely a plate in the T351 temper bent to a structure with a 1000 mm radius and not further aged.

This comparative product is representative of a product processed according to the second prior art method, but not yet machined. The machining would not remove residual stresses in the metal remaining after machining.

The comparative product is also representative of a product processed according to the first prior art method because the distortion caused by bending a plate would also arise in the first prior art method which includes a plate bending step.

The data at paragraph [0048] shows the comparative example has a longitudinal distortion of 0.15 to 0.22 mm which can be calculated to a residual stress in the longitudinal direction of 49 to 54 MPa. In contrast, the distortion in the product of the present invention has a longitudinal distortion of 0.07 to 0.09 mm which can be calculated to a residual stress in the longitudinal direction of 16 to 22 MPa. This is unexpectedly lower.

The invention as currently claimed provides a method of manufacturing an integrated monolithic aluminum structure being part of a wing skin or a frame portion for an aircraft, the aluminum structure being made from specifically defined AA7xxx-series aluminum alloy. The method involves two distinct heat treatments, one heat treatment carried out prior to shaping, preferably the shaping is by means of bending, and a second heat treatment after shaping, and after which the integrated monolithic aluminum structure is machined from the shaped structure.

The presently claimed invention also has various significant advantages not suggested by the alleged AAPA. As explained by the present specification at page 8, lines 8-19, an advantage of the present invention is that it uses less aluminum for machining or milling since the predetermined thickness "y" of the alloy plate 4 is considerably smaller than a predetermined thickness of the whole aluminum block. Furthermore, by an ageing step after the shaping, it is possible to obtain essentially distortion-free structural members suitable for, e.g., aircraft fuselage and wing applications. Another advantage of the method and the product of the present invention is that it provides a thinner final monolithic product or structure that has strength and weight advantages over thicker type products produced over conventional methods. This means that designs with thinner walls and less weight may be provided and approved for use. Yet another advantage of the method and the product of the present invention is the weight reduction of the monolithic part. Weight is further reduced also by the possible elimination of fasteners.

AMENDMENT

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This is related to the accuracy advantages in the machining operation resulting from the reduced distortion, and the inherent accuracy of final machining after forming.

III. Conclusion

In view of the above it is respectfully submitted that all objections and rejections are overcome. Thus, a Notice of Allowance is respectfully requested.

Please charge any underpayment for the concurrently filed Amendment, Notice of Appeal or Petition for Extension of Time, or credit any overpayment, to Deposit Account No. 19-4375.

IV. Request for Interview

The undersigned for Applicant requests an interview, in particular to discuss how the combined references lack cold forming prior to ageing, and how Warner et al. and Quist et al. teach opposite directions of crystallization.

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By:

Respectfully submitted,  
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